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SPACE COMMUNICATIONS

by

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SPACE COMMUNICATIONS

AMERICAN-MADE SATELLITES, able to relay voice messages to any point on earth, may link the nations of the world in a space communications network within a decade. Scarcely more than a dream five years ago, communications satellites now are not only feasible but also urgently needed. If overseas telephone calls continue to increase at the current rate of 20 per cent a year, existing cable and radiotelephone facilities will be seriously overloaded by 1965 if not sooner. Extension of these facilities, it is argued, would be more costly and time-consuming than establishment of a satellite communications system. Such a system, moreover, would make possible world-wide television broadcasts.

A committee composed of representatives of 10 international communications carriers[1] already is drafting plans for a commercial satellite network. Formed on July 25 at the urging of the Federal Communications Commission, the committee was asked to submit recommendations to the F.C.C. by Oct. 13. President Kennedy had announced, July 24, that the administration favored private ownership and operation of the U.S. portion of a space communications system, provided certain policy stipulations were met.

A commercial satellite network, the President said, should be in operation "at the earliest practicable date" and should supply global service, extending even to areas where coverage might not be profitable.[2] He specified also that provision should be made for foreign participation in the undertaking. Non-discriminatory use and equitable access "by present and future authorized carriers," effective competition in the purchase of equipment, "maximum

[1] American Cable and Radio Corp., American Telephone and Telegraph Co., Hawaiian Telephone Co., Press Wireless Inc., Radio Corporation of Puerto Rico, RCA Communications Inc., South Puerto Rico Sugar Co., Tropical Radio Telegraph Co., United States-Liberia Radio Corp., Western Union Telegraph Co.

[2] A White House memorandum of Sept. 1 stated: "While global coverage is the ultimate objective, it would not be sound and realistic to withhold the services within the system's capability until total coverage had been completed."

possible competition" among participating carriers, and "full compliance with antitrust legislation" must be assured. And the enterprise must provide economical service "the benefits of which will be reflected in overseas communications rates."

The government, Kennedy declared, would cooperate in the space communications venture. It would promote research and development; conduct negotiations with nations using the system; arrange launching of U.S. rockets used to place the satellites in orbit; establish a separate satellite system for governmental use, if needed; assure effective use of the radio frequency spectrum; supply technical assistance to newly developing countries wishing to use the system; and seek with other countries the most constructive role for the United Nations, including the International Telecommunication Union, to play in global space communications.

Use of Passive Satellites for Communications

Echo I, the huge inflatable sphere orbited by the United States on Aug. 12, 1960, proved the effectiveness of "passive" communications satellites. Unlike an "active" satellite, Echo does not carry instruments for receiving, amplifying and re-transmitting signals beamed to it from the ground; it acts merely as a signal reflector. Within two hours of launching, a message recorded by President Eisenhower was sent from California to New Jersey by bouncing radio waves off Echo. The experiment took on added significance because a solar storm had disrupted conventional long-distance radio communications at the time Eisenhower's voice was being beamed from one coast to the other. In the following two weeks Echo was used to relay a two-way telephone conversation between the California and New Jersey stations; to transmit voice and music signals from New Jersey to England; and to send a facsimile photograph from Iowa to Texas. Altogether, the satellite has been involved in more than 150 communications experiments.

Not the least of Echo's achievements has been its longevity. Originally expected to stay aloft only two weeks, it has already remained in orbit for more than 13 months. The National Aeronautics and Space Administration, in charge of the Echo project, recently said the sphere may circle the earth for several more years. Now perforated

by micro-meteorites, Echo has become wrinkled and less efficient as a reflector, but it still is capable of transmitting radio waves.

NASA plans to launch a second Echo satellite sometime in 1962.[3] Like its predecessor, Echo II will contain sublimating powder which changes to gas in the near-vacuum of outer space, thereby inflating the sphere. Tests of the sphere's tensile strength, conducted during the summer, indicate that Echo II may retain its shape for as long as 10 years in orbit. In subsequent experiments under NASA's Project Rebound, three satellites of the Echo II type will be placed in orbit from a single space vehicle. The space agency plans two Rebound launchings in 1963, with communications tests to be conducted from ground stations in the United States, Great Britain, France and possibly other countries.

Project West Ford, an Air Force program, represents a somewhat different approach to passive space communications. The project calls for orbiting a Midas reconnaissance satellite that would release 350 million hairlike copper wires, each less than an inch long. The wires would be spread in a band about five miles thick and 24 miles wide, circling the earth in polar orbit at an altitude of 2,000 miles. Too small to damage spacecraft, the wires would be exactly the length to reflect a large portion of the world's radio waves in the vicinity of 8,000 megacycles. In this way, the Air Force hopes, foolproof radio communications will be provided even in polar regions, where communications blackouts are frequent.[4]

West Ford was opposed by the International Astronomical Union in a resolution adopted Aug. 24 at a meeting in Berkeley, Calif. The Soviet Academy of Sciences also protested a month later. Objections were based on the assertion that the belt of copper wires would interfere with radio telescopes, which record weak radio signals from star systems that lie beyond the range of optical instruments. However, a Defense Department official said at the

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[3] Echo I, 100 feet in diameter and weighing 137 pounds, is made of plastic about one-half the thickness of the cellophane wrapping on a package of cigarettes. Its outer coating of aluminum was deposited as vapor. Echo II is to be 135 feet in diameter and weigh more than 500 pounds. The laminated sphere will consist of two thin sheets of aluminum foil with plastic film between them.

[4] Communications in the polar regions are unreliable because bursts of protons from the sun are deflected there by the earth's magnetic atmosphere. The concentration of protons produces a dense layer of ionization that absorbs radio signals.

end of August that the first West Ford test would be held "in a few weeks." [5]

Two Major Types of Active Satellite Systems

Passive satellites, because they carry no instruments, are not subject to mechanical failure and are relatively inexpensive to construct. Even so, they are considered less efficient than active satellites, for they require costly ground equipment capable not only of sending a powerful signal into space but also of receiving the reflected signal when it returns, greatly weakened, to earth. Much smaller ground stations can be used in connection with active satellites, which contain battery-powered receivers, amplifiers and transmitters.[6]

Two types of active satellite systems are currently under development. The Army's Project Advent and NASA's Project Syncom are concerned with so-called synchronous satellites. When circling the earth at an altitude of 22,300 miles, a satellite of this type will complete an orbit in exactly 24 hours and thus, if moving in the same direction as the rotation of the earth, maintain a fixed position in relation to a given point on the ground. Three such satellites placed at equal distances around the equator could provide virtually world-wide communications coverage. They would supply a minimum of 3,600 voice circuits, compared with the 500 which are now available for transoceanic use.

Many technical problems remain to be solved, however, before a synchronous satellite system can become operable. It has not been ascertained, for example, whether the United States possesses the rocket capacity to place an object in so precise an orbit. And any synchronous satellite would have to carry controls to prevent it from drifting out of orbit and to keep its antennae pointed toward the earth. This equipment would substantially increase satellite weight and, consequently, the amount of rocket thrust that would be needed to send the satellite into orbit.

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[5] Harold Brown, director of defense research and engineering, in testimony Aug. 24 before a House Commerce subcommittee.

[6] Essential to the success of active satellites has been the development of the solar cell as a source of energy for storage batteries. Mounted on the satellite's outer shell, solar cells generate electric energy when exposed to sunlight and can withstand the severe changes in temperature encountered when the satellite enters and leaves the earth's shadow. The cells consist of silicon wafers only three times thicker than a human hair. As many as 20,000 such cells have been mounted on a single satellite.

COMMUNICATIONS SATELLITE PROJECTS

Project name	*Sponsoring agency*	*Type of satellite*	*Scheduled tests*
Advent	Army	Synchronous	1962
A.T. & T.	NASA	Delayed repeater	1962
Echo	NASA	Inflatable sphere	1962*
Rebound	NASA	Inflatable sphere	1963-64-65
Relay	NASA	Delayed repeater	1962
Syncom	NASA	Synchronous	1962
West Ford	Air Force	Copper wires	1961

* First satellite in program orbited in 1960.

The second active satellite system, considered the more feasible at present, would require as many as 50 "delayed-repeater" satellites to provide global radio, telephone and television service. Moving in polar orbits about 7,000 miles above the earth, these satellites would relay signals to and from some 26 ground stations situated on every continent.[7] To make the system effective, at least one satellite would have to be within visual range of each station at all times. The stations, in turn, would require tracking antennae to follow each satellite as it passed overhead.[8] If one satellite should experience an equipment failure while in orbit, signals could be beamed to another. Delayed-repeater satellites do not need orbital or antenna controls. They thus have the advantage of being smaller, lighter, and less costly to build than synchronous satellites.

NASA and the American Telephone and Telegraph Co. plan to place delayed-repeater satellites in low-altitude orbits sometime next year. Forerunner of this experiment was Project ATLAS-SCORE, which sent the first "talking" satellite aloft on Dec. 18, 1958. Equipped with a pair of radio and tape recorder units, the SCORE[9] satellite broadcast a pre-recorded Christmas message from President Eisenhower to five U.S. tracking stations. The Army's Courier I, essentially a refinement of SCORE, performed a similar feat last Oct. 4 when it helped relay a message from Eisenhower to Secretary of State Christian A. Herter at the United Nations.

[7] The network described here is that proposed by the American Telephone and Telegraph Co., but the principles involved apply to all delayed-repeater satellite systems.

[8] Teletype or voice messages are transmitted by a ground station while the satellite is within visual range. The messages are stored on magnetic tape inside the satellite. As the satellite passes another ground station at any point in its orbit around the earth, a coded command signal is sent to the satellite, which then broadcasts its stored-up messages and records new messages for relay to another station.

[9] An acronym formed from the words Signal Communications by Orbiting Relay Equipment.

NASA's entry in the delayed-repeater satellite field is Project Relay, which will determine the effects of radiation on satellite components and attempt to relay transatlantic broadcasts of telephone, telegraph and television signals. NASA will cooperate also in A.T. & T.'s plan to orbit as many as four delayed-repeater satellites in 1962. A.T. & T. is to design and build the satellites at its own expense and reimburse the government for costs of launching and use of tracking facilities.

CAPACITY, RELIABILITY AND COST OF SPACE SYSTEM

Use of microwave radio will enable space satellites to handle a far greater volume of transoceanic communications than either radio telephones or undersea telephone cables. First employed for overland transmission in 1946, microwave is a broad-band radio system that can provide several hundred voice circuits per channel.[10] Such a system is feasible for transmitting messages across large bodies of water only in conjunction with satellites. Microwaves travel in straight lines and will soar into space if not intercepted by a series of relay towers. To send a microwave signal from the United States to Europe in this way would require a tower 475 miles high in mid-ocean. But communications satellites, orbiting at considerably higher altitudes, would in effect constitute a network of relay towers spanning all the oceans.

Satellites are potentially capable of transmitting world-wide television broadcasts.[11] J. H. Felker, assistant chief engineer for A.T. & T., asserted last May 10 that a space communications network might ultimately include 20 channels, each consisting of 600 voice circuits or one television circuit. This would require the use of 5,000 megacycles of the radio frequency spectrum—more than 10 times the number on the present television broadcast band. In any event, world-wide television must await standardization of receiving equipment; European sets, for example, receive more and finer lines on their screens than American sets.

There is every indication that satellites, barring equipment failures, will provide more dependable service than existing transoceanic communications facilities. Experiments have shown that space communications will be al-

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[10] By contrast, the most advanced transoceanic telephone cable yet developed provides only 60 two-way voice circuits.

[11] Existing undersea cables have not sufficient capacity to transmit television signals.

most immune to the effects of solar storms, which unpredictably disrupt long-distance radio transmissions reflected off the upper atmosphere. Satellites, moreover, are less vulnerable to damage than undersea telephone and telegraph cables, which have been cut from time to time by fishing trawlers.[12]

Estimates of the cost of a space communications network range from $100 million to $500 million, depending on the number and type of satellites to be used. Sizable as these sums may appear, they are far smaller than the investment that would be needed to provide world-wide telephone and television service by means of undersea cables. There is virtually unanimous agreement in government and business circles that a space network will become a profit-making venture within 20 years of its inception.[13]

Propaganda Value of New Phone and TV Network

Establishment of a space communications system might conceivably have a propaganda impact comparable to that of some of the Soviet Union's space pioneering achievements. The House Committee on Sciences and Astronautics has said winning the initial prestige value of such a system is crucial. The United States Information Agency, asserting that communications satellites may revolutionize its operations, has urged fastest possible development of a global network.

While this country appears at the moment to have a substantial lead in communications satellite technology, the Soviet Union is reported also to be active in the field. American scientists who have talked to Soviet space experts say that the Russians are keenly interested in space communications and are concentrating on a synchronous satellite system.[14] Russia's acknowledged edge in rocket thrust may mean that it already has the capability to place synchronous satellites in the required orbit. U.S. officials are

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[12] Western Union cables suffered 65 cable cuts off Newfoundland in the period 1954-58, all due to trawlers.

[13] "Lockheed Aircraft Corp. expects all revenues from space communications eventually will run as high as $3 billion a year. Assistant Army Secretary Richard S. Morse estimates that private satellites will yield income of 'several billions of dollars' per year by the late 1970s and Lloyd V. Berkner, chairman of the National Academy of Science's Space Science Board, says that satellite communications will be a $100 billion business within 20 years."—Gerald J. Barry and Henry Simmons, *Newsweek*, May 8, 1961, p. 84.

[14] An official of the Soviet Ministry of Communication said in January 1959 that the current Seven-Year Plan was expected to include "the basic measures for realization of a cosmic television program transmitter" to broadcast in color.

convinced that the first nation to come up with a feasible network will dominate the space communications field for years to come.

Development of Overseas Communications

VOICE COMMUNICATIONS across the oceans had their beginning almost half a century ago. A spoken message transmitted from the U.S. Navy radio station at Arlington, Va., to the navy yard at Mare Island, Calif., Sept. 29, 1915, was overheard at Pearl Harbor, Hawaii. Three weeks later, on Oct. 21, 1915, a speech broadcast from Arlington was heard both in Honolulu and atop the Eiffel Tower in Paris. It was not until 1927, however, that the first commercial telephone circuit was opened, making possible telephone conversations between persons in the United States and Great Britain. Extension of radiotelephone facilities followed rapidly; by 1932 it was possible to place a call from the United States to Japan, the Philippines, Hawaii, Netherlands Indies (now Indonesia) and to most of the nations of Europe and of Central and South America.

In the early years of commercial service, overseas rates were high and consequently calls were few. Only 2,500 overseas calls were completed in 1927, when three minutes of transatlantic conversation cost $75. Subsequent rate reductions, together with improvements in the quality of voice transmission, have produced a steady increase in overseas telephone traffic. About 1.4 million calls were placed in 1956, the last year in which transoceanic telephone communications were handled mostly by radio. The basic rate, in 1956 as today, ranged from $9 (on Saturdays and Sundays) to $12 (on weekdays) for the first three minutes of a call from the United States to almost any point on the globe. The Bell System reported last spring that it could make telephone connections with 163 foreign "countries and areas."

As the volume of overseas telephone calls mounted, it became obvious that the limited number of frequencies available for radiotelephone service was inadequate. The Bell System met the problem by laying a double-strand submarine cable from Nova Scotia to Newfoundland and

thence to Scotland. The twin strands, opened for service in 1956, provided 36 two-way voice circuits. Bell System cables of like design and capacity now link North America with France, Hawaii, Puerto Rico and Alaska. A British Commonwealth cable, with 60 two-way voice circuits in a single strand, is currently being laid from Scotland to Newfoundland.

Transoceanic cables had been used for many years before 1956, but only for transmitting telegraph messages. Use of cables for telephone relay was contingent upon development of electronic amplifiers small enough to fit inside a cable and durable enough to provide service for 20 years or more. Without frequent reinforcement during the long undersea journey, voice signals would become too weak to be distinguishable from the ever-present transmission noise. Each of the telephone cables now in operation contains amplifiers placed at 40-mile intervals. The American Telephone and Telegraph Co. has said that the cables "make talking between continents like talking across the street," for "atmospheric disturbances, which sometimes cause fading or distortion on overseas radiotelephone calls, have no effect." [15]

Every advance in transoceanic telephone capacity has been matched by corresponding increases in overseas calls. In 1957, the first full year of cable traffic, the number of calls rose to 1.7 million. The following year, marked by the opening of the U.S.-Hawaii cable, calls numbered 2.7 million. The 1960 total was 3.6 million. If the current rate of increase (about 20 per cent annually) should continue, the total would reach 20 million by 1970 and 100 million a decade later. The Bell System has estimated that 10,000 overseas circuits will be needed by 1980 for telephone use alone.[16] It is this prospect that makes communications satellites so attractive in the eyes of commercial carriers.

Ownership and Regulation of Existing Systems

Communications systems in most foreign countries are owned and operated by governments. In the United States, on the other hand, communications services are provided by privately owned companies operating under government

[15] *American Telephone Share Owners' Quarterly*, Autumn 1959, p. 3.
[16] Bell Telephone System, *Communicating by Satellite* (March 1961), p. 4.

regulation. Under the Radio Act of 1927, the federal government undertook to license radio stations and operators, assign wave lengths, and exercise other powers to preserve "the public interest, convenience and necessity" in radio communications. The Communications Act of 1934 created the Federal Communications Commission and empowered it to regulate "interstate and foreign commerce in communication by wire and radio." Control of communications for governmental use was vested in the President; this authority in recent years has in effect been delegated to the Interdepartment Radio Advisory Committee, which is composed of representatives of federal agencies using the radio spectrum.

When allocating radio frequencies, both F.C.C. and I.R.A.C. are bound by regulations formulated by the International Telecommunication Union. Now a specialized agency of the United Nations, the I.T.U. is the successor of the International Telegraph Union, formed in 1865. I.T.U. at present has 101 members and associate members, including most countries of the world except Communist China, East Germany, North Korea and North Viet Nam.

The regulations for use of radio for telegraphy, telephony, television, radar, navigation aids and astronomy are drafted at I.T.U. conferences and incorporated in multilateral treaties subject to ratification by member nations. Seven I.T.U. conferences have been held since 1906; the next is tentatively scheduled for the autumn of 1963. At that time, it is expected, regulations governing use of the radio spectrum in outer space will be drafted.

Control of and ownership of international communications facilities, such as submarine cables, is shared by the communications companies and foreign government agencies that use them to provide service to the public. The Bell System at present has 160 working agreements with overseas telephone companies and governments. It has said that many of the agreements could easily be modified to make provision for a space communications network. At least three communications satellite programs already have an international flavor. The British General Post Office and the French Center for Telecommunications Studies agreed, April 4, to provide ground stations needed for Projects Relay and Rebound. And on Sept. 11 the British announced that they would participate also in the

space communications experiments to be carried out jointly by NASA and A.T. & T.

American Predominance in Communications Field

A global space network obviously would benefit all nations, but perhaps none so much as the United States. One-half of the world's telephones, radio sets and television receivers are in this country. In 1960, the United States had 166 million radio sets,[17] compared with 178.6 million elsewhere in the world; 70.8 million[18] of the world's 133.6 million telephones; and 54 million television sets as against 43 million in all other countries combined. It follows that much of the potential market for world-wide telephone and television service lies in North America.

It is equally clear that underdeveloped lands, in which global communications might be expected to have great educational impact, are unprepared to participate in a satellite network. There are only 13 million telephones in all of Asia, Africa and Latin America. For most persons living on those continents, a telephone or television set is a costly and sometimes useless luxury. An A.T. & T. official pointed out in an address on May 10 that satellites "do not today make it possible to get television into areas that are not equipped with a network of broadcast stations." He explained: "They only permit reception at one point with a costly and elaborate receiver that will be economically justifiable only if there is a network to be fed. Neither do satellites permit you to bring good telephone service into areas that do not already have a good terrestrial network." President Kennedy presumably had these considerations in mind when he said, July 24, that this country was ready to help "developing countries . . . attain an effective global system as soon as practicable."

When he addressed the U.N. General Assembly, Sept. 25, the President urged "linking the whole world in telegraph, telephone, radio and television" through a satellite communications system as one means to help prevent "the cold reaches of the universe" from becoming a new arena of "an even colder war."

[17] Includes sets in homes, government and business establishments and automobiles.

[18] Between 1950 and 1960 the number of telephones in the United States increased by about 30 million. The world telephone total was only 88 million as recently as 1954.

Control of Space Communications Network

DISPUTES over ownership, rather than technological problems, threaten to obstruct early development of a space communications network. Doubt has been expressed that the "maximum possible competition" among participating companies sought by President Kennedy is a practical objective. The assertion has been made that A.T. & T., which now supplies 85 per cent or more of domestic and transocean telephone service, will inevitably attain a dominant position in a space system. Hostility toward the company seems to stem from its involvement in antitrust actions. A.T. & T.'s most recent run-in with the government occurred in 1949, when the Justice Department demanded that it divest itself of the Western Electric Co., a wholly owned subsidiary which supplies most of the equipment used by the Bell System.[19] The company emerged victorious in 1956, when a consent decree made no mention of divestiture.

Debate Over Ownership of Proposed System

Frederick T. Kappel, board chairman of A.T. & T., declared in a speech at Boston on Sept. 21 that the "concept that Bell System management is out to dominate and control space communications simply has no basis in fact." Kappel pointed out that a space communications system had to be "a world-wide system to be of greatest use," but he said "the rest of the world will likely own more of it than is owned by the United States." A booklet on space communications put out by the Bell System last spring stated:

> Use of the U.S. portion of the satellite system, including ground stations, could be shared by all U.S. international communications carriers for any services the Federal Communications Commission might authorize them to provide. Many other companies and industries would share in the business opportunities that the development of a satellite communications system would provide. Most of the money spent for electronic gear and other equipment and services would go to companies outside the Bell System.

[19] See "Telephone Monopoly," *E.R.R.*, 1949 Vol. I, pp. 119-136. Assistant Attorney General Lee Loevinger told an official of the Commercial Telegraphers Union, in a letter made public last May 24, that the Department of Justice was "conducting an investigation" of possible antitrust violations in A.T. & T.'s new Telpak point-to-point communications system. When the letter was interpreted as heralding a full-scale antitrust investigation, and heavy selling of A.T. & T. stock followed, the Justice Department insisted that the inquiry was no more than "a routine check into some complaints it has received."

Rockets and launching for the satellite system would also be supplied by private industry.[20]

The company foresees division of ownership of the proposed commercial network between A.T. & T. and other American and foreign-owned communications carriers or agencies. It has asserted that allocation of ownership according to use of the system is "the only practical course." If foreign government communications agencies buy one-half of the network's stock, as expected, A.T. & T. would end up with about 80 per cent of the American portion, or 40 per cent of the total.

These and similar considerations might ultimately cause the Kennedy administration to withdraw its endorsement of private ownership of the commercial space network.[21] Louis K. Kohlmeier, commenting on this possibility in the *Wall Street Journal*, Sept. 12, remarked:

> The really significant pressure [against private ownership] is not coming from old-line advocates of government over private ownership. It's coming from some congressmen and other government officials who were arguing for the private enterprise arrangement sanctioned in July. Even some members of the Federal Communications Commission, who helped make that decision, are reconsidering now. The backtrackers have been disillusioned, they say, by raucous infighting among some large corporations, with the eager assistance of some influential congressmen, over how private ownership and control should be set up.

Disagreement over who should participate in the space venture erupted early this year, when the current policy was in process of formulation. The F.C.C. invited interested companies, March 29, to submit recommendations for organization and operation of a commercial satellite system. A.T. & T., already drafting its own space plans, proposed that participation be restricted to existing international carriers. General Electric Co., with the backing of Lockheed Aircraft Corp., Western Union Telegraph Co. and other concerns, recommended that equipment manufacturers also be allowed to participate. In a ruling handed down May 24, the F.C.C. endorsed A.T. & T.'s proposal; it asserted that admission of the equipment industry to the space network might "well result in encumbering the sys-

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[20] Bell Telephone System, *Communicating by Satellite* (March 1961), p. 11.

[21] The *New Republic* pointed to a possible reason for the present policy, Aug. 7: "Space vehicles may make much of the existing privately owned communications industry obsolete. . . . The administration has concluded, apparently, that it would be wiser to give the communications industry a stake in these new systems to avoid the necessity of bailing out, at some future date, the hundreds of thousands of private and institutional investors who own shares in A.T. & T. and other concerns."

tem with complicating and costly corporate relationships." The commission thereupon invited eight international carriers to attend an exploratory meeting on June 5. Protests by equipment and other concerns finally led F.C.C. to invite five additional companies,[22] but in the end only two of the five—both international carriers—were named to the committee charged with organizing a commercial satellite network.[23]

Even if the committee's plan, scheduled to be submitted Oct. 13, should meet all of the President's policy requirements, it would be a long way from execution. F.C.C. will probably spend several months studying the proposals, and it may then ask for recommendations from other interested parties. Further delays will ensue as the commission drafts rules, subject to revision, for licensing satellite communications carriers. Moreover, any party dissatisfied with the final F.C.C. decision can appeal to the federal courts.

Role of Government in Space Communications

It cannot be assumed that placing a commercial space communications network under government ownership would appreciably speed its development. At least three federal agencies in addition to F.C.C. are involved in the communications satellite field, but none has charge of formulating over-all plans. NASA, the civilian space agency, is concerned with scientific developments; the Pentagon, with national security implications of global communications; the State Department, with conducting negotiations for assignment of space radio frequencies. With authority thus dispersed, a certain duplication of expenditure and effort has ensued. NASA and the Army, for example, are each developing synchronous satellite programs, the experimental aims of which are virtually identical.[24]

Federal ownership, it is argued, would be preferable to private ownership in the eyes of many foreign governments. Dallas W. Smythe, former chief economist of F.C.C., declared, Aug. 3, that a privately owned satellite system would "confirm the worst elements in the foreigners' image of our country and its culture." If this is true, a highly

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[22] General Electric, General Telephone & Electronics Corp., Lockheed, RCA Communications Inc., Western Union.

[23] See footnote 1 for list of 10 companies on committee.

[24] Until last year, NASA was involved only in passive satellite programs. Under the terms of an agreement with the Defense Department, Aug. 24, 1960, it received authority to move into the active satellite field.

profitable system in private hands would give Communist propagandists a new excuse to portray the United States as a country run by selfish industrialists.

Military-Civilian Differences on Technical Points

Although it is widely agreed that active satellites are superior to passive satellites for communications purposes, opinion is sharply divided on which type of active space capsule—synchronous or delayed-repeater—is preferable. Military officials generally advocate a synchronous system, asserting that it would be less susceptible to enemy radio jamming. At least four communications companies[25] also are known to favor the synchronous approach, but since only one of them is represented on the F.C.C. committee of international carriers, their views carry little weight at present.

The major advocate of a delayed-repeater satellite network is A.T. & T. In opposing use of synchronous satellites, the company contends that they cannot supply satisfactory telephone circuits. Because of the very high orbital altitudes of synchronous satellites—22,300 miles—a radio signal transmitted by this system would take six-tenths of a second to complete the trip from one ground station to another.[26] This seemingly short transmission time, A.T. & T. asserts, would actually result in "serious deterioration in the quality of telephone service." Addressing members of the American Iron and Steel Institute in New York last May 24, James B. Fisk, president of Bell Telephone Laboratories, explained:

> Although you are probably not aware of it, you usually hear your own echo on a telephone, coming back so fast over the wire that it is nearly simultaneous with your speech. . . . In every long distance call, we eliminate the echo by suppressing the sound from the other direction as long as a person is talking. Then the other person has difficulty breaking in until the first talker stops. In coast-to-coast calls in this country, the system works well, because the delay is short. But with a six-tenths second delay, the speaker will not usually hear a reply until more than six-tenths of a second later after he stops talking. We find that in a dynamic conversation a talker may be only partially successful in his attempt to break in, with the result that his speech sounds mutilated. Or, he may be completely unsuccessful. Then he is talking to empty air, so to speak. And his own voice may

[25] General Telephone & Electronics, Hughes Aircraft Corp., Lockheed, RCA.

[26] By contrast, a telephone signal traveling from Europe to Hawaii through land lines and submarine cables—the longest cable communication now possible—completes the trip in two-tenths of a second.

even override the incoming speech from the other talker. Then the effect is utter confusion.

Delayed-repeater satellites, circling the earth at altitudes of 7,000 miles, can relay voice messages in one-tenth of a second. For this reason alone, according to A.T. & T., they promise to supply the best possible space telephone service. Military officials take a different view of space communications. They are interested in satellites primarily as a means of transmitting coded data, not subject to enemy eavesdropping, rather than voice messages. The matter of transmission time is therefore not a controlling factor in military space communications planning.

Problem of Distributing Space Radio Frequencies

A space communications network is certain to make heavy demands on the world's limited supply of radio frequencies. In one band alone (between 4 and 10 megacycles), the world total of frequency listings increased from 1,698 in 1929 to 74,284 in 1959. The I.T.U. set aside 13 frequency bands for space use and one for radio astronomy in 1959, but the allocations were understood to be only temporary. At its next scheduled meeting in 1963, the I.T.U. will have to consider permanent frequency assignments for four specified areas of space research:

1. Transmission between earth and space—This involves communication through the earth's upper atmosphere, which is known to be "frequency selective"; that is, only certain frequencies are able to pass through what has been termed a "spectrum window" in a straight line between spacecraft and ground. Other frequencies, such as those now used for commercial radio broadcasting and long-distance radio telephony, are reflected off the upper atmosphere.

2. Transmission for research on propagation characteristics of the upper atmosphere—Scientists want to study the nature of those areas of the atmosphere which reflect radio signals.

3. Bands for use in radio astronomy—These frequencies must be protected from interference if there is to be satisfactory reception of the weak signals emitted by distant star systems.

4. Telecommunications between two or more space vehicles outside the earth's atmosphere.

The need for international cooperation in controlling space radio frequencies is readily apparent. Without strict controls, commands sent to space vehicles would be subject to interference, data transmitted back to the earth might be distorted, and identification of satellites might be dif-

ficult. It is conceivable that space rockets might even malfunction because of stray radio signals.

F.C.C. made public last May its preliminary views on allocating space frequencies, with the purpose of "obtaining the ideas and reactions of other countries." The agency's final proposals will go to the State Department with a recommendation that they be used as a basis of discussion with foreign governments. Should an American space communications network be in partial operation by 1963, or show promise of going into operation soon thereafter, the proposals may win wide acceptance among I.T.U. members. The Soviet Union's views on the matter of space frequencies are unknown. Washington officials suspect that the Communists may attempt to head off any international agreement until such time as they are ready to put a communications satellite system in orbit.